Letters to the Editor

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DATING OF SOME NUCLEAR EXPLOSIONS FROM RADIO-ACTIVE FALL-OUT MEASUREMENTS IN CALCUTTA

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Measurements of the intensity and nature of radio-active fall-out has been systematically carried out in our laboratory since the inception of the last nuclear test series. During the course of our investigation, numerous samples of radio-active fall-out were collected both from rain-borne dusts and from military aeroplanes making routine flights upto altitudes of about 40,000 ft. The samples having high specific activity were normally used for determining the dates of explosion, following the method of Yamasaki and Kaneko[1] as discussed below :

It is well-known that the gross activity of fall-out due to an atomic explosion is given by

$$I_t = I_0 t^{-n} , \qquad \ldots \quad (1)$$

where I_0 is the activity at the end of unit time (say one day) after the explosion and I_t is that after 't' days, and 'n' usually takes a value between 1.2 and 1.7[2,3,4,5]. Since the date of explosion T_0 is unknown, the measurements on the samples are made on dates T_1 and T_1' giving activity I_1 and I'_1. Then,

$$\left.\begin{aligned} I_1 &= I_0 t_1^{-n} \\ \text{and} \quad I'_1 &= I_0 t'^{-n}_1 \end{aligned}\right\} \qquad \ldots \quad (2)$$

where $t_1 = T_1 - T_0$, $t'_1 = T_1' - T_0$ i.e. the time elapsed from the date of explosion.

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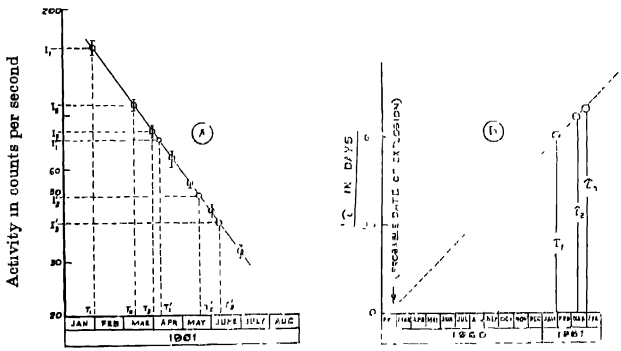
Putting $T'_1 - T_1 = t'_1 - t_1 = \tau_1$, we obtain from equation (2)

$$\tau_1 = \{(I_1/I'_1)^{1/n} - 1\} t_1, \tag{3}$$

and if we take T'_1 so that the ratio I_1/I_1' becomes equal to any value K (say 2) and repeat the same procedure at least once more and determine the dates T_2' for any arbitrary T_2 and so on, satisfying the relation $I_m/I'_m = K$, we obtain a straight line on a $\tau - t$ diagram Its slope gives the value of 'n', and by an extrapolation to $\tau = 0$, we can find the date where $t = 0$, i.e. T_0

The actual procedure is to measure the β-activity of a sample from time to time, and the counting rates thus obtained are plotted as a function of the date of measurement on a semilogarithmic paper as shown in Figs 1(A) and 2(A). Taking I_1 as the initial count corresponding to any arbitrary time T_1 (date of initial



Date Date

Fig. 1. The determination of I_m and T_m ($I_m/Im' = 2$) The determination of T_0.

measurements) one measures I'_1 (equal to, say $\frac{1}{2} I_1$) and determine T'_1. T_1 and $\tau_1 = T'_1 - T_1$ are thus obtained. Repeating the same procedure, T_2 and τ_2, T_3 and τ_3, and so on are obtained. The values of 'τ' are plotted as a function of the date of measurement 'T' on a graph paper as shown in Figs. 1(B) and 2(B). These plots should lie on a straight line so long as 'n' remains constant throughout the measurements. Then the straight line is extrapolated back to τ_0, and the date of explosion T_0 is found.

The results of two typical cases are given below, one of which (case 1) corresponds to the French test in Sahara on 13th February 1960, while the other (case 2) relates to the Russian '50' megaton Hydrogen Bomb test in the Arctic region on 23rd October 1961.

Case 1

The sample was collected on 30th January, 1961. Fig. 1(A) shows the decay curve plot of β-activity measurements extending over a period of about seven months. The date of explosion has been determined from the plot in Fig. 1(B). The extrapolated date of explosion in this case has been found to be 12th February 1960, while the actual date of French test in Sahara was 13th February 1960. The value of 'n' in this case has been found to be 1.2.

Case 2.

The sample was collected on 3rd January 1962. Fig. 2(A) shows the decay curve plot of β-activity measurements extending over a period of about

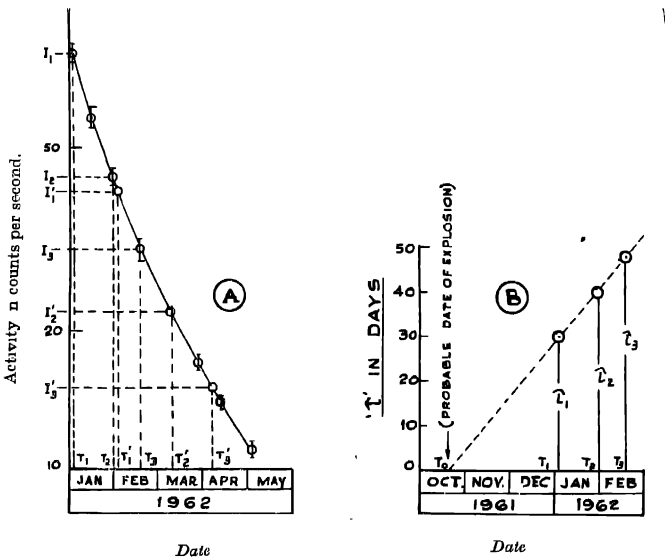


Fig. 2. The determination of I_m and T_m ($Im/lm = 2$) The determination of T_0

six months. The date of explosion has been determined from the plot in Fig. 2(B). The extrapolated date of the explosion in this case has been found to be 21st October 1961, while the actual date of Russian '50' Megaton Hydrogen Bomb explosion was 23rd October 1961. The value of 'n' in this case has been found to be 1.3.

It is interesting to note that the β-activity of the radio-active debris from the Russian Megaton bomb explosion, as shown in Fig. 2(A), exhibits a rapid rate

of decay while that from the French atomic bomb as shown in Fig. 1(A), exhibits a relatively slower rate of decay.

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